AJT

THIS IS NOT AN OFFICIAL PUBLICATION, IT IS SUPPLIED FOR INFORMATION, AND MAY NOT BE QUOTED IN PRINT.

EVAPORATION MEMO NO 22

B G WALES-SMITH

ESTIMATION OF APPROXIMATE AVERAGE HEIGHTS (ABOVE MSL) OF 40X40 KM SQUARES COVERING GREAT BRITAIN

1. Introduction

A hydrometeorological model for the calculation of evaporation and associated estimates required the preparation of a set of average heights for grid squares. This memorandum describes a simple exercise designed and carried out to obtain the required estimates of average height.

2. The average height of an area between two map contours

Consider a conical hill with its base at sea level and its axis vertical; a cross-section including the axis is shown as the upper part of Fig 1. The lower part of Fig 1 shows a quarter of the hill as it would appear on a map. The point A has been chosen to represent the map contour of height $\frac{OP}{2}$ on the line OB.

C is a point on OB chosen so that

$$OB^2-OC^2=OC^2-OA^2$$

i.e. that the area BCC'B' = ACC'A'

and thus the contour CC' would divide the land represented by the plan area ABB'A' into halves.

If $OB^2-OC^2=OC^2-OA^2$

$$2.OC^2 = OB^2+OA^2$$

$$OC = \sqrt{\frac{OB^2 + OA^2}{2}}$$

Now we have chosen OA = AB = 1

thus $OC = \sqrt{\frac{4 + 1}{2}} = 1.5811$

If AQ = 100 m (a.s.l.) and B is at sea level

then (approximately) RC = 40 m and CC' is the 40 m countour.

This approximate method of finding the "average height contour", AC:CB = 6:4 , is only valid when OA = AB. In Fig 2 we see the size of the error involved when OA

varies from $\frac{1}{4}$ AB to 2 AB.

3. Estimation of 40X40 km square average heights

Base map used. Met O 3 relief map of the British Isles on scale 1 cm = 20 km, having National Grid and contours at 100, 200, 400 and 600 metres a.s.l. with shading.

Average heights used

0 - 100 m	40 m
100 - 200 m	140 m
200 - 400 m	280 m
400 - 600 m	480 m
$>$ 600 m	760 m

Method

The decimal fractions of each 40X40 km square occupied by each of the shaded areas occurring therein were assessed by eye and multiplied by the appropriate average heights; these products were summed. Calculations were made on an electronic desk machine with accumulation facility.

The process was repeated using a second map and with the first map out of sight. Average estimates were compared, square by square. Final estimates were obtained as follows:

1. Larger estimate $\leq$ 100 m if difference $\leq$ 10%* accept mean
   $>$ 100 m $\leq$ 200 m " $\leq$ 12% "
   $>$ 200 m $\leq$ 250 m " $\leq$ 15% "
   $>$ 250 " $\leq$ 17% "

   * of larger estimate.

2. If differences greater than percentage of larger estimates listed in 1. re-estimate very carefully. If 3rd estimate $>$ larger of first two estimates
   or $<$ smaller " " "
   mean with nearer of first estimates.
   If 3rd estimate between first two estimates accept it.

Out of 187 estimates 27 were worked a third time.

The final estimates are shown as Fig 3.

October 1972

Meteorological Office
Bracknell

Fig. 1.

CROSS-SECTION AND 1/4 PLAN OF CONICAL HILL WITH BASE AT SEA LEVEL AND AXIS VERTICAL.

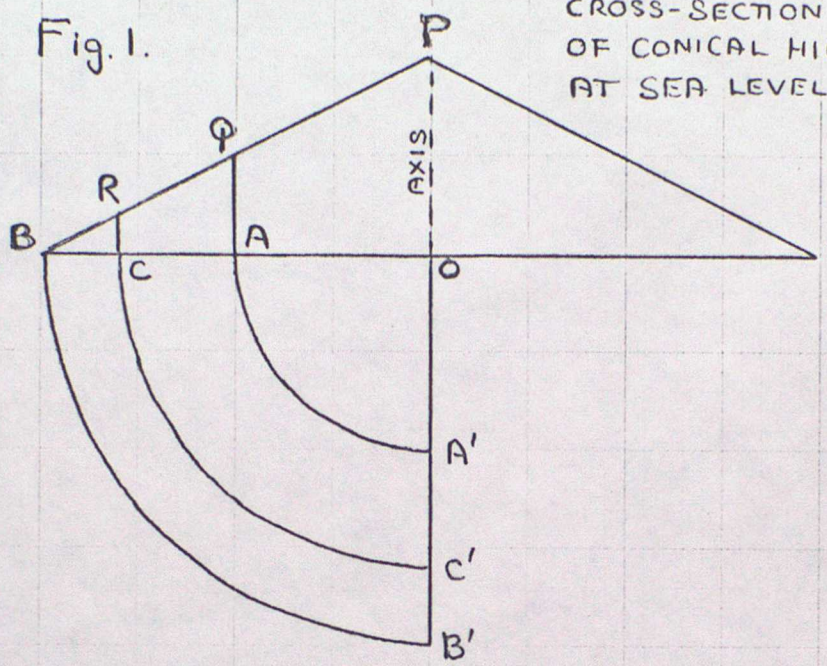
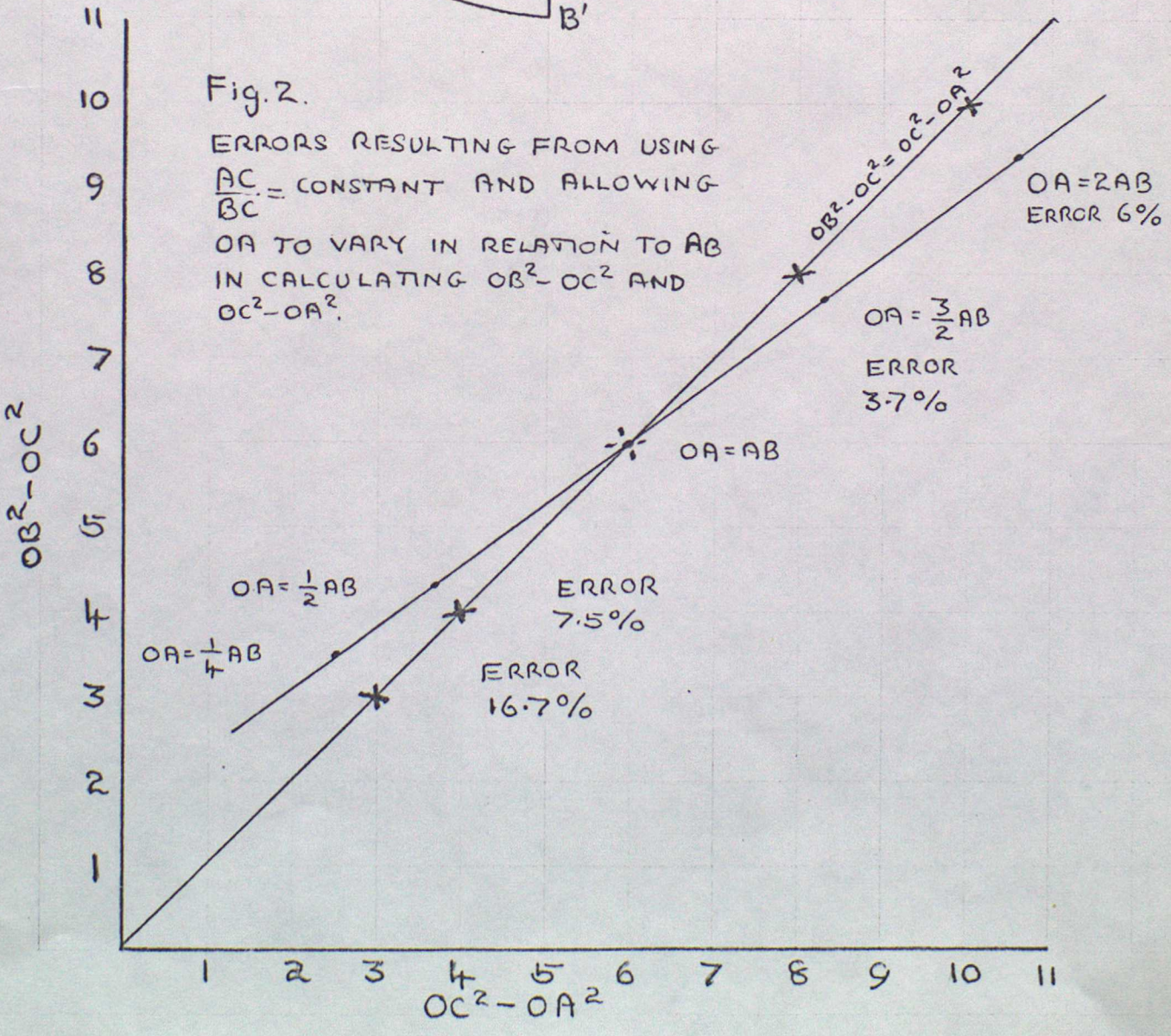
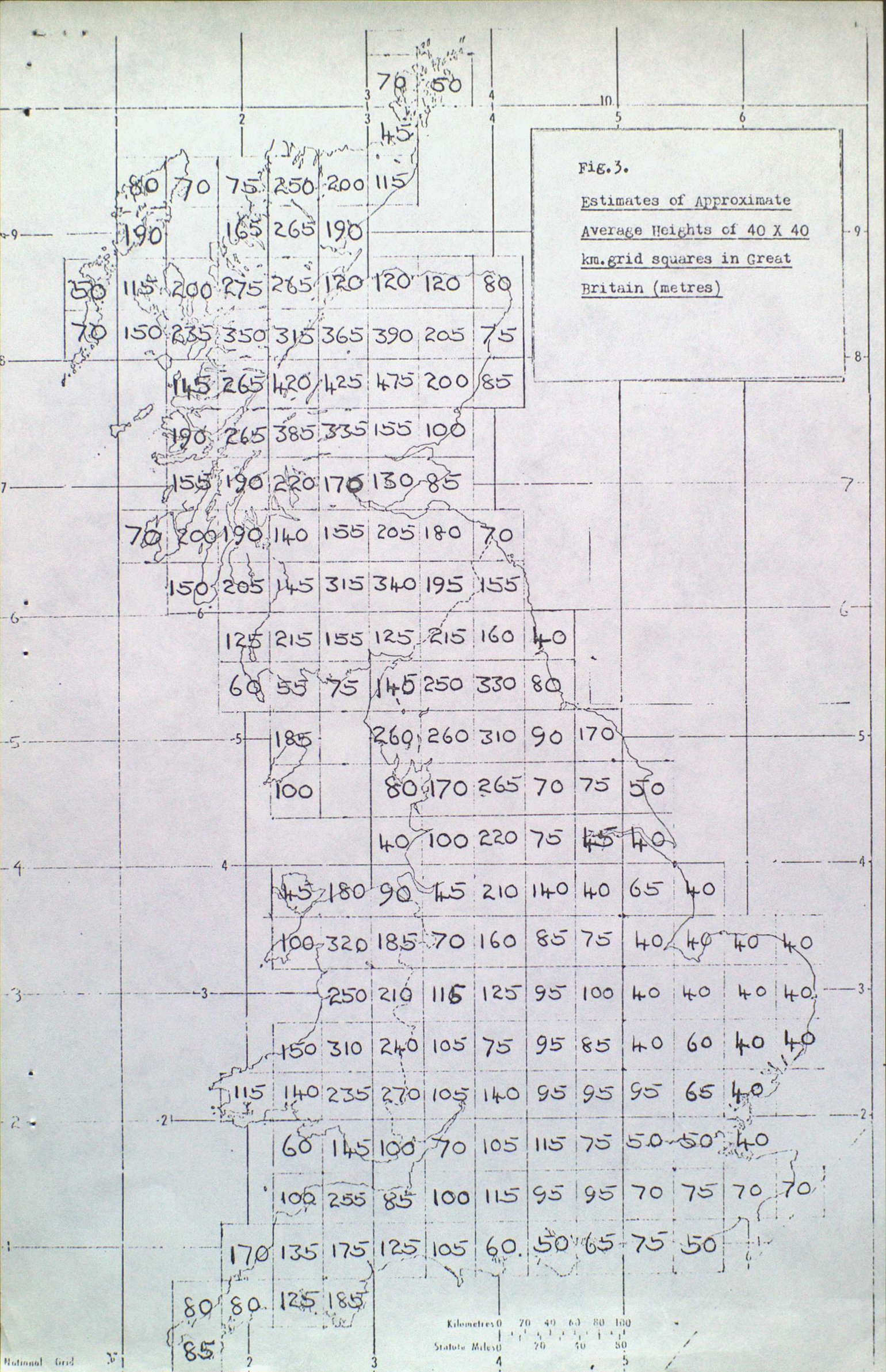


Fig. 2.

ERRORS RESULTING FROM USING $\frac{AC}{BC}$ = CONSTANT AND ALLOWING OA TO VARY IN RELATION TO AB IN CALCULATING $OB^2 - OC^2$ AND $OC^2 - OA^2$.




70 60
45
80 70 75 250 200 115
190 165 265 190
50 115 200 275 265 120 120 120 80
70 150 235 350 315 365 390 205 75
145 265 420 425 475 200 85
190 265 385 335 155 100
155 190 220 170 130 85
70 200 190 140 155 205 180 70
150 205 145 315 340 195 155
125 215 155 125 215 160 40
60 55 75 145 250 330 80
185 260 260 310 90 170
100 80 170 265 70 75 50
40 100 220 75 45 40
45 180 90 45 210 140 40 65 40
100 320 185 70 160 85 75 40 40 40 40
250 210 115 125 95 100 40 40 40 40
150 310 240 105 75 95 85 40 60 40 40
115 140 235 270 105 140 95 95 95 65 40
60 145 100 70 105 115 75 50 50 40
100 255 85 100 115 95 95 70 75 70 70
170 135 175 125 105 60 50 65 75 50
80 80 125 185
85
Fig.3.
Estimates of Approximate Average Heights of 40 X 40 km. grid squares in Great Britain (metres)
Kilometres 0 20 40 60 80 100
Statute Miles 0 20 40 60
National Grid